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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY  
(Chapter II of the Patent Cooperation Treaty)



(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 11321-P061WO	<b>FOR FURTHER ACTION</b>		See Form PCT/IPEA/416
International application No. PCT/US2004/001708	International filing date (day/month/year) 23.01.2004	Priority date (day/month/year) 23.01.2003	
International Patent Classification (IPC) or national classification and IPC G01L1/22			
Applicant WILLIAM MARSH RICE UNIVERSITY			

- This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 7 sheets, including this cover sheet.
- This report is also accompanied by ANNEXES, comprising:
  - ☐ sent to the applicant and to the International Bureau) a total of sheets, as follows:
    - ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
    - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
  - ☐ (sent to the International Bureau only) a total of (Indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

- This report contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand  09.08.2004	Date of completion of this report  11.03.2005
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer  Coda, R  Telephone No. +49 89 2399-2802  

**INTERNATIONAL PRELIMINARY REPORT  
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**Box No. I Basis of the report**

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4)
  - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements\*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

**Description, Pages**

1-20 as originally filed

**Claims, Numbers**

1-61 as originally filed

**Drawings, Sheets**

1/8-8/8 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

Novelty (N)	Yes: Claims	3, 16, 17, 20, 23, 24, 29, 32-37, 42-50, 54, 56-61
	No: Claims	1, 2, 4-15, 18, 19, 21, 22, 25-28, 30, 31, 38-41, 51-53, 55
Inventive step (IS)	Yes: Claims	
	No: Claims	3, 16, 17, 20, 23, 24, 29, 32-37, 42-50, 54, 56-61
Industrial applicability (IA)	Yes: Claims	1-61
	No: Claims	

2. Citations and explanations (Rule 70.7):

**see separate sheet**

**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability;  
citations and explanations supporting such statement**

1. The subject-matter of claims 1, 2, 4 to 15, 18, 19, 21, 22, 25 to 28, 30, 31, 38 to 41, 51 to 53 and 55 is not new (Art. 33(2) PCT).
  - 1.1 With respect to independent claim 1, the document D1 (US2002/0172820 A1) discloses a device for measuring mechanical conditions comprising: a sensing elements with a plurality of carbon nanotubes and an electrical probe in contact with the nanotubes (see page 10, paragraphs [130], [132]; page 11, paragraph [137]). Therefore, the subject-matter of claim 1 is not new.
  - 1.2 The document D2 (WO00/14476) discloses an apparatus according to claim 1 (see page 1, lines 4 to 7; page 2, lines 9 to 13, 17 to 19; page 6, lines 12, 13, 23 to 25). Therefore, the subject-matter of claim 1 is not new also with respect to the document D2.
  - 1.3 The document D3 (US6276214 B1) discloses an apparatus according to claim 1 (see column 1, lines 8 to 16; column 2, lines 50 to 55; column 3, lines 3 to 5; column 7, lines 44 to 58; claims 6, lines 5 to 7). Therefore, the subject-matter of claim 1 is not new also with respect to the document D3.
  - 1.4 With respect to independent claim 18, the document D3 discloses also the comparison of the property change to a database correlating the property change to the mechanical condition and the assignment of a value to the mechanical conditions (see column 7, lines 44 to 60. The database is considered to be implicitly disclosed by the use of a correlation performed by a computer). Therefore, the subject-matter of claim 18 is not new.
  - 1.5 With respect to independent claim 26, the document D4 (WO03/005450) discloses a device for measuring mechanical conditions comprising: a sensing elements with a plurality of carbon nanotubes, a source of electromagnetic radiation and a photoluminescence detector (see page 5, lines 8 to 16; page 19, lines 23 to 25;

page 23, line 18; page 38, lines 13 to 15; page 47, lines 30 to 32;

Therefore, the subject-matter of claim 26 is not new.

- 1.6 With respect to independent claim 51, the document D1 discloses also a device for measuring mechanical conditions comprising: a sensing elements with a plurality of carbon nanotubes and a thermal conductivity probe (see page 3, paragraphs [38, ], [39]; page 10, paragraph [130]; page 11, paragraph [137]).

Therefore, the subject-matter of claim 51 is not new.

- 1.7 The dependent claims 2, 4 to 15, 19, 21, 22, 25, 27, 28, 30, 31, 38 to 41, 52, 53 and 55 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty, the reasons being as follows:

- claims 2, 11 to 15, 19, 21, 22, 25: the correlation, the materials, the article of manufacture, the resistance and the strain detection are disclosed in the document D3 (see column 7, lines 44 to 61; column 3, line 55 to column 4, line 5; column 3, line 12).
- claims 4 to 10, 52, 53, 55: the resistance, the strain detection, the various nanotubes, the matrix, the source of thermal energy and the polymers are disclosed in the document D1 (see page 11, paragraph [137]; page 3, paragraph [37]; page 1, paragraph [8]; page 4, paragraph [68]; claim 3; page 14, paragraphs [165], [169]; page 3, paragraphs [38], [39]; page 12, paragraph [145]);
- claims 27, 28, 30, 31, 38 to 41: the various nanotubes, the radiation sources, the detector, the spectra analysis and the various materials are disclosed in the document D4 page 31, lines 4 to 6; page 36, lines 20 to 23; claim 513; page 109, lines 29 to 31; page 108, lines 4 to 11).

2. The subject-matter of claims 3, 16, 17, 20, 23, 24, 29, 32 to 37, 42 to 50, 54 and 56 to 61 of the present application cannot be considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

- 2.1 As far as the independent claims 48 and 60 are concerned, their subject-matter differs from the sensor disclosed in the documents D4 and D1 respectively in that a

comparison of the photoluminescence or, respectively, of the thermal conductivity change to a database correlating this change to the mechanical condition is performed and the assignment of a value to the mechanical conditions is executed.

2.2 The problem to be solved by the present invention may therefore be regarded as how to provide a sensor with low energy requirements.

2.3 The solution proposed in claims 48 or 60, respectively, of the present application cannot be considered as involving an inventive step for the following reasons:

- (i) the document D4 discloses a device for measuring mechanical conditions comprising a sensing elements with a plurality of carbon nanotubes as indicated at point 1.5 above. The sensor of D4 can also collect real time data and it can be included in an integrated system comprising a reader and a computer controlled response device, which can be activated based on the detector data provided to and processed by the computer (see page 67, line 30 to page 68, line 4). The computer therefore executes a database correlation and a value assignment during the data elaboration process. This system integration has the advantage that the obtained device has a small size and low energy requirements (see page 68, lines 7, 8).
- (ii) Therefore the skilled person would regard it a normal design procedure to include the system disclosed respectively in the documents D4 and D1, comprising respectively a photoluminescence or thermal conductivity change sensing, into an integrated system as the one described in the document D4 in order to provide a sensor with low energy requirements.

2.4 The dependent claims 3, 16, 17, 20, 23, 24, 29, 32 to 37, 42 to 47, 49, 50, 54, 56 to 59 and 61 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step, the reasons being as follows:

- claims 3, 16, 17, 20, 29, 32, 33, 37, 46, 47, 49, 50, 54, 61: the use of a four-point probe, the networks, the detection range the multispectral analysis, the correlation, the reverse chemical modification, the polymers, the photoluminescence detection and the thermocouple is merely one of several straightforward possibilities from which the skilled person would select,

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(SEPARATE SHEET)**

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without the exercise of inventive skill, in order to improve the system reliability;

- claims 23, 24, 34 to 36: the use of the strain detection, the various nanotubes (see the document D2, page 3, lines 16, 17, 23 to 25), and the homogeneity and the chemical modification (see the document D1, page 11, paragraph [137]; page 1, paragraph [8]; page 4, paragraph [68]; claim 3), is merely one of several straightforward possibilities from which the skilled person would select, without the exercise of inventive skill, in order to improve the detector flexibility;
  - claims 42 to 45, 56 to 59: the attachment to an article of manufacture is a normal design procedure for the skilled person in order to improve the system performance (see the document D3, column 3, line 55 to column 4, line 5).
3. Although claims 1, 18, 26, 48, 51 and 60 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection. Hence, claims 1, 18, 26, 48, 51 and 60 do not meet the requirements of Article 6 PCT.
4. The structure of the claims is not clear because claim 50 is repeated twice. Therefore, the claims do not meet the requirements of Rule 6(1)(b) PCT. Claim 50 should appear only once and the following claims should be renumbered.